

**A GROUP DECISION MAKING MODEL CONSIDERING
EXPERTS COMPETENCY: AN APPLICATION
IN PERSONNEL SELECTION**

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Abstract

The paper deals with the problem of group decision making in the case, where experts are with different background experience and different field of competency. An optimization model is proposed to cope not only with evaluation criteria but also with group members competency. The different level of members competency is expressed by introducing weighted coefficients composed of two parts – objective and subjective. The objective part refers to the background experience while the subjective part affects advisability of expert area to the particular decision making problem. The proposed group decision making model is illustrated in case of personnel selection. The obtained results demonstrate the applicability of the model and its usefulness in personnel selection.

Key words: group decision making, optimization model, coefficients for expertise, personnel selection

1. Introduction. Multi-criteria decision making (MCDM) is a well-known part of decision making. The generic term MCDM envelops all methods assisting the decision making process in accordance with the preferences of decision maker

in cases of existing of multiple conflicting criteria [1]. The selection in decision making is realized from predefined number of decision alternatives described by their attributes [2]. The interest in multiple attribute group decision making (MAGDM) has increased dramatically in recent years. That is why different approaches are proposed to cope with this problem. A generic conceptual framework and a classification scheme of MAGDM methods are described in [3]. MAGDM includes group of experts (decision makers) who provide evaluations regarding performances of the alternatives in respect to the evaluation criteria [4]. As the real problems are multi-dimensional problems, experts from different fields are to be involved.

In modern society, qualified personnel is of great importance due to the rapid development of technologies. This makes the problem of personnel evaluation and selection very important activity for every enterprise. Thus, personnel selection can be considered a complex MAGDM problem due the requirement for different abilities for a particular position. Different authors proposed various methods for MAGDM. An intuitionistic fuzzy multi-criteria group decision making method with grey relational analysis is proposed and applied to the ranking and selection. Intuitionistic fuzzy weighted averaging operator is utilized to aggregate individual opinions of decision makers into a group opinion [5]. A decision support tool is developed using an integrated analytic network process and fuzzy data envelopment analysis approach to effectively deal with the personnel selection problem [6]. Based on Karnik–Mendel algorithm, an analytical solution to fuzzy TOPSIS method is proposed [7]. To make the recruitment process more reasonable, analyzing Analytic Hierarchy Process based on the fuzzy multiple criteria decision making model is used to achieve the goal of personnel selection [8]. The preferences of more than one decision maker are internally aggregated into the TOPSIS procedure [9].

It should be noted, that experts in the group may have different backgrounds and knowledge on the investigated problem. This requires the use of some metrics to express the different qualification of group experts. Despite the variety of proposed MAGDM methods there is no unique direction to make differences between experts in group decision making. Most authors emphasize on aggregation of utility function to express the alternatives performance [10] or deal with linguistic or fuzzy expression of preferences [11,12].

The article proposes an optimization model to deal with the different levels of competence of group members by introducing weighted coefficients consisting of two parts: 1) an objective part that relates to past experience and 2) a subjective part, which reflects the suitability of the experts for the problem.

The rest of the paper is organized as follows: Section 2 proposes group decision making model taking into account the expertise of the group members. Section 3 illustrates an application of personnel selection using the proposed group decision making model. Section 4 presents the obtained results and compares the

results with extension of TOPSIS for group decision making. Section 5 summarizes the main results and draws conclusions.

2. Group decision making model taking into account difference in expertise of group members. The basic formulation of MCDM problem is usually expressed in the following matrix format [9]:

$$(1) \quad D_k = \begin{matrix} & C_1 & C_2 & \dots & C_n \\ A_1 & \left[\begin{matrix} r_{11}^k & r_{12}^k & \dots & r_{1n}^k \end{matrix} \right] & \left[\begin{matrix} w_1^k \\ w_2^k \\ \vdots \\ w_n^k \end{matrix} \right] \\ A_2 & \left[\begin{matrix} r_{21}^k & r_{22}^k & \dots & r_{2n}^k \end{matrix} \right] \\ \vdots & \left[\begin{matrix} \vdots \\ \vdots \\ \ddots \\ \vdots \end{matrix} \right] \\ A_m & \left[\begin{matrix} r_{m1}^k & r_{m2}^k & \dots & r_{mn}^k \end{matrix} \right] \end{matrix}$$

where the given set of alternatives are denoted by A_1, \dots, A_m , C_1, \dots, C_n are evaluation criteria, performance rating of A_i toward C_j from k -th expert is expressed by r_{ij}^k and w_j^k represents the weight for j -th criterion from k -th expert.

Each expert determines weights for criteria w_j^k , such that $\sum_{j=1}^n w_j^k = 1$.

To make more effective selection in determination of the most preferable alternative of the group, the rating of alternatives and criteria weights of each group member should be considered of different importance. This could be expressed by different levels of competency including previous experience, level of position and responsibilities, availability of certificates for qualifications, etc. For this purpose, the corresponding relevant competency of each group member is proposed to be expressed by weighted coefficients. These considerations are taken into account by formulation of the following optimization group decision making problem:

$$(2) \quad \max \begin{bmatrix} x_1 \\ x_2 \\ \dots \\ x_m \end{bmatrix} \left(\alpha^1 \begin{bmatrix} r_{11}^1 & r_{12}^1 & \dots & r_{1n}^1 \\ r_{21}^1 & r_{22}^1 & \dots & r_{2n}^1 \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1}^1 & r_{m2}^1 & \dots & r_{mn}^1 \end{bmatrix} \begin{bmatrix} w_1^1 \\ w_2^1 \\ \dots \\ w_n^1 \end{bmatrix} + \dots + \alpha^k \begin{bmatrix} r_{11}^k & r_{12}^k & \dots & r_{1n}^k \\ r_{21}^k & r_{22}^k & \dots & r_{2n}^k \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1}^k & r_{m2}^k & \dots & r_{mn}^k \end{bmatrix} \begin{bmatrix} w_1^k \\ w_2^k \\ \dots \\ w_n^k \end{bmatrix} \right)$$

subject to

$$(3) \quad \sum_{k=1}^q \alpha^k = 1,$$

$$(4) \quad \sum_{j=1}^n w_j = 1,$$

$$(5) \quad \sum_{i=1}^m x_i = 1, \quad x_i \in \{0, 1\},$$

where r_{ij}^k is the performance rating of i -th alternative toward j -th criterion according to k -th expert (group member), w_j^k is the coefficient for relative importance between criteria for k -th expert, α^k is weighted coefficient that expresses the level of expertise of k -th expert, and x_i are binary decision variables assigned to each alternative to perform a single selection.

The weighted coefficients for relevant competent expertise of group members consist of objective and subjective part. The objective part concerns the experience of expert in the particular field. This includes previous experience involving acquired knowledge, responsibilities related with different projects, availability of publications, etc. The subjective part is formed by the advisability of relevance area to the particular decision making problem. All of these considerations are represented as aggregation function of experience in the particular field and advisability of relevance area to the particular problem as follows:

$$(6) \quad \alpha^k = \beta^k + \gamma^k,$$

where β is the coefficient that expresses the experience of expert in years and γ is the coefficient for advisability of expertise field competency to the particular problem.

The coefficient for experience is an objective coefficient while the coefficient for advisability is subjective and is determined by stakeholders or by higher managers authorized to manage the decision process. The values of the coefficient of advisability are within the interval $[0, 1]$.

Obviously there are no restrictions to compose other functions to express the expertise of the group members. For example, some probability logic could be used to express the second coefficient related with advisability of expertise area to the particular problem [13]. Regardless of the used function for determination of weighted coefficients for relevant competent expertise of group members, some normalization is to be done to obtain dimensionlessness of each of these coefficients.

The criteria could also require some normalization when there are different scales to obtain a common scale to enable aggregation and to make comparable criteria to get the overall score for each alternative. Some of the proposed normalization schemes for multi-criteria decision making could be used [14].

3. Application in personnel selection. The applicability of the proposed decision-making model considering experience and knowledge of group members is numerically tested in case of personnel selection. The input data for numerical testing are adopted from human resources selection example, where some relevant tests with benefit attributes are to be evaluated [9]. Four experts have been appointed to evaluate 17 qualified candidates in regard to results from knowledge tests, skill tests and interviews as shown in Table 1.

The performance rating score of candidates and weights for criteria importance are represented in normalized values. The criteria for knowledge tests and

Table 1

Weighted decision matrix

Criteria	Candidates																	E-1	E-2	E-3	E-4
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17				
Language test	80	85	78	75	84	85	77	78	85	89	65	70	95	70	60	92	86	0.066	0.042	0.060	0.047
Professional test	70	65	90	84	67	78	83	82	90	75	55	64	80	80	78	85	87	0.196	0.112	0.134	0.109
Safety rule test	87	76	72	69	60	82	74	72	80	79	68	65	70	79	87	88	80	0.066	0.082	0.051	0.037
Professional skills	77	80	80	85	75	81	70	80	88	67	62	65	75	80	70	90	70	0.130	0.176	0.167	0.133
Computer skills	76	75	85	65	85	79	71	78	90	77	70	60	70	85	66	85	72	0.130	0.118	0.100	0.081
Panel interview	80	65	90	65	75	80	65	70	80	70	50	60	75	80	70	90	80	0.216	-	-	-
1-on-1 interview	75	75	85	70	80	80	70	60	85	75	60	65	75	70	65	95	85	0.196	-	-	-
Panel interview	85	60	80	55	75	75	70	75	95	75	62	65	80	75	75	92	70	-	0.215	-	-
1-on-1 interview	80	70	85	60	80	85	60	65	85	80	65	75	80	72	70	90	75	-	0.255	-	-
Panel interview	75	70	80	68	50	77	65	75	90	68	60	50	65	80	65	85	75	-	-	0.203	-
1-on-1 interview	70	77	90	72	55	82	72	67	85	78	65	60	75	70	70	80	80	-	-	0.285	-
Panel interview	90	60	90	62	70	75	67	82	90	65	65	45	70	75	60	88	70	-	-	-	0.267
1-on-1 interview	85	70	95	72	75	75	75	85	92	70	70	50	75	75	65	90	75	-	-	-	0.326

T a b l e 2

Weighted coefficients for expertise
of the group members

Case	Weighted coefficients for expertise			
	E-1	E-2	E-3	E-4
Case-1	0.25	0.25	0.25	0.25
Case-2	0.12	0.15	0.35	0.38
Case-3	0.18	0.27	0.33	0.22

skill tests are considered objective while the interviews are considered subjective. The scores for objective criteria are obtained as a sum of corresponding scores for tests. The score for performance of candidates toward subjective criteria from interviews are determined by each particular expert in the same range as the tests results. In this evaluation process each expert determines also his own coefficient for relative importance between evaluation criteria.

To test the proposed model (2)–(5), three different cases of weighted coefficients for expertise of the group members are used as shown in Table 2.

The input data from Table 1 and 2 are used to formulate the corresponding optimization task, the solution of which will determine the most preferable alternative.

4. Results analysis and discussion. The proposed group decision making model (2)–(5) takes into account not only alternatives evaluations and weights of criteria importance but also considers relevant competent expertise of members within a group. The used binary variables allow determining the most preferable alternative by single run of task. Data from Table 1 and three different cases for expertise of group members (Table 2) determine the following results, as shown in Fig. 1.

Case-1 illustrates the situation with equal level of expertise for all group members. This is the case equivalent to other group decision making approaches which do not make a difference between group members. The solution in this case determines the most preferable alternative corresponding to candidate No 16 with value for objective function of **88.017** (Fig. 1). The same candidate is determined in [9], where extension of TOPSIS model and the same input data are used. Case-2 and Case-3 refer to situation, where each group member has different level of relevant competency and expertise expressed by weighted coefficients (Table 2). When level of competency for experts E-4 and E-3 dominates over the level of experts E-1 and E-2, the solution determines the most preferable alternative corresponding to candidate No 9 with value for objective function of **88.254** (Fig. 1). In Case-3 experts E-2 and E-3 are with higher level of competency than experts E-1 and E-4 and the results show that candidate No 9 is the preferable solution with objective function value of **87.887** (Fig. 1).

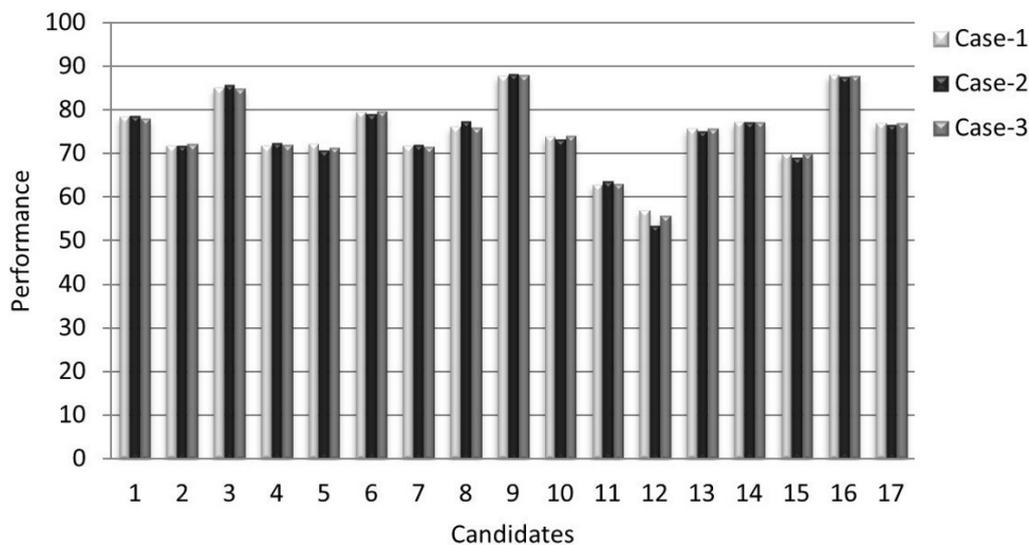


Fig. 1. Candidates performance for three cases for expertise of group members

5. Conclusion. In this paper, an optimization model for group decision making taking into account different levels of competency of group members is proposed. In contrast to the known group decision making methods, the proposed model allows determining of optimal alternative considering also the relevant competent expertise of members within the group. The different level of members expertise is expressed by weighted coefficients composed of two parts – objective and subjective. The objective part refers to the background experience while the subjective part affects advisability of expert area to the particular decision making problem.

The applicability of the proposed model is numerically tested in case of personnel selection. The advantage of the proposed model is the fact that experience and field of expertise of group members can be considered of different importance depending on particular decision making problem. This allows more flexible adjustment of the model to reflect different situations.

Future investigations are related with building of other functions for determination of the level of expertise of members of the group.

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